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Exam 2

Closed book exam. A calculator is allowed, as is one 8.5×11” sheet of paper with your own written notes. Please show all work leading to your answer to receive full credit. Numerical answers should be calculated to 2 significant digits. Exam is worth 100 points, 25% of your total grade.

UF Honor Code: “On my honor, I have neither given nor received unauthorized aid in doing this exam.”

Sphere: $S = 4\pi r^2$ $V = \frac{4}{3}\pi r^3$ $\pi = 3.1415927$ $e = 1.6022 \times 10^{-19}$ C $g = 9.8$ m/s^2

$1\ \mu\text{C} = 10^{-6}$ C $1\ \mu\text{F} = 10^{-6}$ F 1 pF $= 10^{-12}$ F 1 eV $= 1.6 \times 10^{-19}$ J

$K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2/C^2 $\varepsilon_0 = 8.8542 \times 10^{-12}$ C^2/N m^2 $c = 3.0 \times 10^8$ m/s

$k = \frac{K}{c^2} = \frac{\mu_0}{4\pi} = 10^{-7}$ T·m/A $\mu_0 = 4\pi k = 1.257 \times 10^{-6}$ T·m/A $\mu_0\varepsilon_0 = \frac{1}{c^2}$

$\mathbf{F} = K\frac{q_1 q_2}{r^2}\hat{\mathbf{r}}_{12}$ $\mathbf{E} = \frac{\mathbf{F}}{q_0}$ $\Phi_E = \oint \mathbf{E}\cdot d\mathbf{A} = \frac{q_{enc}}{\varepsilon_0}$ $\nabla\cdot\mathbf{E} = \frac{\rho}{\varepsilon_0}$

$\mathbf{E} = -\nabla V$ $V = \frac{U}{q_0}$ $W = -\Delta U = \int \mathbf{F}\cdot d\mathbf{s}$ $\Delta V = -\int \mathbf{E}\cdot d\mathbf{s}$

$Q = C\Delta V$ $U = \frac{1}{2}C(\Delta V)^2 = \frac{Q^2}{2C}$ $C_{eff} = C_1 + C_2$ $\frac{1}{C_{eff}} = \frac{1}{C_1} + \frac{1}{C_2}$

$R = \rho\frac{L}{A}$ $i = \frac{dq}{dt}$ $\tau_{RC} = RC$ $R_{eff} = R_1 + R_2$ $\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\Delta V = iR$ $P = Vi = i^2 R = \frac{V^2}{R}$

$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$ $t = \gamma t_0$ $L = \frac{L_0}{\gamma}$ $x' = \gamma(x - vt)$, $t' = \gamma(t - vx/c^2)$ $y' = y$, $z' = z$

$u_x' = \frac{u_x - v}{1 - \frac{vu_x}{c^2}}$ $u_y' = \frac{u_y}{\gamma\left(1 - \frac{vu_x}{c^2}\right)}$ $E = \gamma mc^2$ $E_K = (\gamma - 1)mc^2$

$\mathbf{p} = \gamma m\mathbf{u}$ $\mathbf{F} = d\mathbf{p}/dt$ $m^2c^4 = E^2 - p^2c^2$ $\mathbf{F} = q(\mathbf{E} + \mathbf{v}\times\mathbf{B})$ $\mathbf{F} = i\,\mathbf{L}\times\mathbf{B}$

$d\mathbf{B} = k\frac{i\,d\mathbf{s}\times\mathbf{r}}{r^3}$ $\oint \mathbf{B}\cdot d\mathbf{s} = \mu_0 i_{enc}$ $\mathbf{B}_{wire} = \frac{\mu_0 i}{2\pi r}\hat{\mathbf{r}} = \frac{2ki}{r}\hat{\mathbf{r}}$

$\boldsymbol{\mu} = i\mathbf{A}$ $\boldsymbol{\tau} = \mathbf{r}\times\mathbf{F}$ $\boldsymbol{\tau} = \boldsymbol{\mu}\times\mathbf{B}$ $U = -\boldsymbol{\mu}\cdot\mathbf{B}$ $F_z = \mu_z\frac{dB_z}{dz}$

$\Phi_B = \int \mathbf{B}\cdot d\mathbf{A}$ $\varepsilon = -N\frac{d\Phi_B}{dt}$

$\mathbf{a}\cdot\mathbf{b} = a_x b_x + a_y b_y + a_z b_z$ $\mathbf{a}\times\mathbf{b} = (a_y b_z - b_y a_z)\,\mathbf{x} - (a_x b_z - b_x a_z)\,\mathbf{y} + (a_x b_y - b_x a_y)\,\mathbf{z}$

1. An *RC* circuit is discharged by closing a switch at time $t = 0$. The initial potential difference across the capacitor is 5 V. The potential difference across the capacitor drops to half of its value in 35 ms.

(a) [6 points] What is the time constant of the circuit?

(b) [4 points] If the total resistance in the circuit is 10 kΩ, what is the capacitance?

2. [8 points] In the circuit shown, the resistances are $R_1 = 6\Omega$, $R_2 = 12\Omega$, and $R_3 = 24\Omega$. The battery voltages are $\mathcal{E}_1 = 18$ V and $\mathcal{E}_2 = 6$ V. What is the current (in amps) flowing through the battery with potential difference $\mathcal{E}_1$?